AUTOMATION AND MECHANIZATION OF PRODUCTION

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PARTICULARS OF USING VIBRATING FEEDERS WITH AN UNBALANCED ELECTRIC DRIVE FOR BATCHING THE BULK COMPONENTS OF A GLASS MIX

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The particulars of using vibrating feeders with an unbalanced electric drive for batching the bulk components of a glass mix are examined. Designs of vibrating feeders which eliminate the effect of resonance phenomena on batching accuracy when an unbalanced vibrator is switched on are presented. A principle is proposed for vibrational-gravitational batching of material that gives two-speed batching with a one-speed unbalanced vibrator.

Key words: vibrating feeder, unbalanced electric vibrator, batch, “rough” loading, “accurate” addition, resonance phenomena.

Vibrating transport-technological mechanisms, such as vibrating feeders, vibrating screens, big-bag stations, and other vibrating bridge breakers and flow rate indicators produced by “Stromizmeritel’” JSC, are together with augur and belt conveyers, elevators, and rocking feeders integral components of lines performing processing, transport, and batching of the initial component of a glass mix [1].

The most commonly used vibrating mechanism are vibrating feeders with electromagnetic and unbalanced electric vibrators, which are used either in fan mix loaders and batching-mixing systems as load feeders and unloaders or as autonomous facilities for off-loading bulk and lumpy materials from the receiving hoppers, feed hoppers, and silos.

The main advantages of vibrating feeders are the comparative simplicity of the construction and lower metal content, possibility of completely sealing the transport chute or pipe hermetically, absence of expensive parts that wear out, and ease of maintenance.

The productivity of vibrating feeders is determined by the width and length of the chute (diameter and length of the pipe), the height of the layer and the speed of the product being mixed, as well as the bulk density of the material, and its physical – chemical characteristics. The productivity of the vibrating feeders with an electromagnetic drive is regulated by means of phase-pulse control and by varying the amplitude of the vibrations, while the feeders with unbalanced electric vibrators are regulated by varying the frequency of the feed voltage. This makes it possible not only to match the operation of the vibrating feeders with other mechanisms of the flow-transport lines but it also increases the accuracy of the batching of the raw materials on transitioning from “rough” to “accurate” feeding of the materials in a weigh batcher.

It should be noted that vibrating feeders with electromagnetic drive have a wider range of smooth regulation than unbalanced vibrating mechanisms and are unaffected by resonance phenomena arising after the vibrator is switched off. However, with respect to a number of indicators (weight, dimensions, cost) they are not as good as vibrating feeders with unbalanced electric drive and because of the large electric losses in the air gap of the electromagnet they cannot have high vibrational amplitudes and high productivity. For this reason it is of interest to increase the operating efficiency of the vibrating feeders with unbalanced electric drive by decreasing the influence of resonance phenomena on the accuracy with which bulk components of the a glass mix are batched.

To increase batching accuracy and prevent material from detaching from the transport chute after the unbalanced drive is switched off the loading feeders of one- and multi-component batchers can be equipped with repeating turning cut-off gates place on the exit opening of the feeders (Fig. 1). When material is fed into the batcher the turning cut-off gate 1

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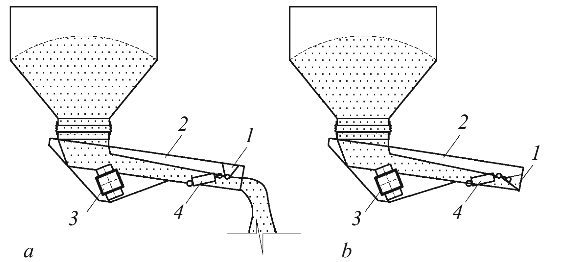

Fig. 1. Vibrating feeder with a cut-off gate: *a*) open gate; *b*) closed gate.

closes (Fig. 1*a*), similarly to the vibrating feeder *2*, and when batching is completed the unbalanced vibrator *3* is switched off and the gate *1*, controlled by a pneumatic drive *4* consisting of two pneumatic cylinders closes the exit of the transporting chute. The effect of the transient resonance phenomena occurring when the unbalanced vibrator *3* is switched off can be additional decreased by means of a scheme for stopping the electric-drive vibrator precisely, which also decreases the probability of spontaneous flow of material out of the transport chute when batching has been completed.

Since the dimensions of the exit opening of the transport chute and the material unloading front remain unchanged when "rough" loading regime is replaced by the "accurate" fill regime, uncontrollable detachment of material with a decrease of the rotational frequency of the unbalanced rotator can arise across the entire width of the chute with a low batching rate also. It is evident that batching accuracy can be increased in this case by decreasing the effective cross section of the unloading opening of the feeder. This technical result is attained by means of a new construction of the transport chute, equipped in the material unloading zone with a depression in the form of a tetrahedral or conical hopper with an opening for "accurate" fill and a turning cut-off gate (RF Patent No. 94551).

The upgraded vibrating feeder equipped with a hopper with an "accurate" fill opening operates as follows. In the initial state (Fig. 2*a*) the unbalanced vibrator *1* is switched off, and the turning cut-off gate *2* placed on the accurate-fill opening *3* is closed. Here the material from the transport chute *4* and the material from the tetrahedral hopper *5* do not enter the receiving hopper of the strain-gauge weighing batcher *6*.

A command from the control system actuates the unbalanced vibrator *1*, and the material from the hopper *7* advances, because of the vibrations of the transport chute *4* and coupled to the hopper by means of seals and spring-opposed suspensions *9*, and is off-loaded from the transporting chute *4* into the receiving hopper of the weigh batcher (Fig. 2*b*). A regime of intense or "rough" unloading of the material starts, during which the hopper *5* is filled first and then the material with a prescribed productivity, determined by the parameters of the vibrating feeder, is intensively poured off all the entire width of the transport chute 4.

When the "rough" unloading has been completed (about 97 – 98% of the weighed mass in the batcher *6*), the control system for the batching process switches off the vibrator *1*, and off-loading of the material from the chute *4* stops. After the weighing system and the vibrating feeder settle down and (2 – 3 sec), during which time a negligible part of the batched material can pour off the edge of the chute *4* into the batcher *6* because of transient phenomena, a signal from the control system actuates the pneumatic drive *10*, and the disconnected turning gate *2* opens. The accurate-fill regime for the material starts (Fig. 2*c*).

Since the cross-sectional area of the accurate-fill opening *3* is 10 – 30 times smaller than the transverse section of the transport chute *4*, outflow of material from hopper *5* under gravity is 10 – 30 times slower than in the "rough" loading regime. Once the accurate-fill process has been completed the control system actuates the pneumatic drive *10*, and the turning cut-off gate closes. A small amount of material, whose level below the level of the material located directly in the transport chute *4*, remains in the hopper *5*; this creates a potential barrier and eliminates the effect of the detachment of material from the transport chute *4* if external mechanical vibrations arise. In turn, this also increases the batching accuracy.

In summary, the presence in the off-loading zone of material from the transport chute of a recess in the form of a tetrahedral hopper with an accurate fill opening and turning

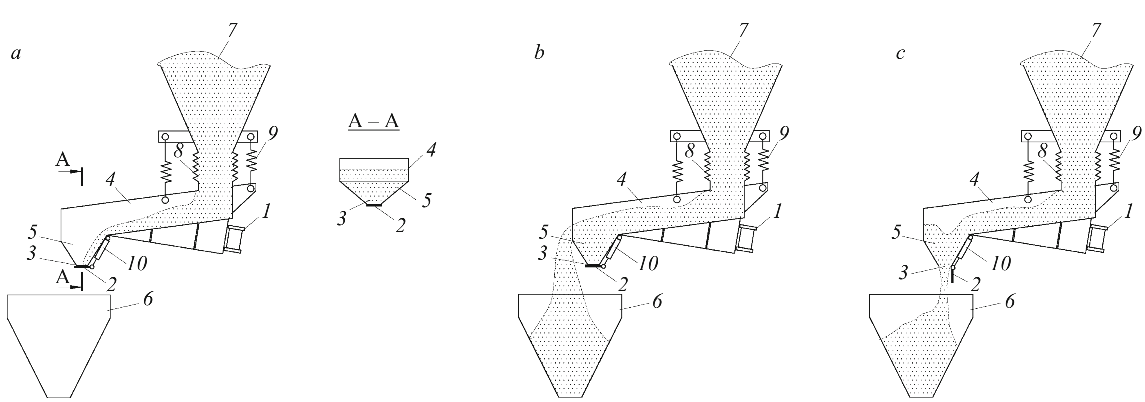

Fig. 2. Vibrating feeder with an accurate-fill chamber: *a*) initial state; *b*) "rough" loading regime; *c*) "accurate" fill regime.

cut-off gate, makes it possible to use a one-speed operating regime of the unbalanced vibrator with two-speed vibrational-gravitational feeding of material into the batcher as well as to eliminate an expensive frequency regulator and a scheme for precise stopping of the electric motor of the vibrator.

Another implementation of a vibrating feeder with an unbalanced electric vibrator, proposed by the present authors (positive decision for awarding a patent for an invention on the basis of application No. 2009131543 dated August 19, 2009), used a similar principle of the vibration – gravity loading of material into the batcher and operates as follows. In the initial state (Fig. 3*a*) the unbalanced vibrator *1* is off, and the cut-off turning gate *2*, placed in the unloading opening *3* of the accurate fill hopper *4*, is closed. When the unbalanced vibrator *1* is actuated, the material from the feed hopper *5*, because of vibrations of the transport chute *6*, connected with the feed hopper by means of the seals *7* and spring-opposed suspensions *8*, starts to more toward the loading opening *9* of the hermetic case *10* (Fig. 3*b*). The sealing casing is additionally equipped with seals *11*, which lower the dusting of the material during operation of the vibrating feeder, and the feed hopper *12*, separated by means of the vertical barrier *13* in the rough-loading chamber *14* and the accurate-fill chamber *4*. The bulk of the material (this is determined by the position of the barrier *13*) pouring from the chute *6* passes through the "rough" loading chamber *14* and enters the receiving hopper of the strain-gauge weighing batcher *15*. At the same time a portion of the material is cut off by the barrier *13* and pours into the accurate-fill chamber *4*, gradually filling it. After the accurate fill chamber is filled, the smaller part of the material which was cut off from the main flow pours into the "rough"-fill chamber.

Once the "rough" loading regime has been completed (for example, 95% of the sieved mass in the batcher *15*) the system controlling the batching process switches off the vibrator *1* and unloading of material from chute *6* stops. Next, the accurate fill regime starts (Fig. 3*c*). During this regime the pneumatic drive *16* is actuated and the turning cut-off gate *2* opens. Since the cross-sectional area of the feed opening *3* of the accurate fill chamber *4* is 10 – 20 times smaller than the cross-sectional area of the feed opening *17* of the rough loading chamber *14*, outflow under gravity is 10 – 20 times weaker than in the "rough" loading regime. At the end of the batching cycle the control system switches off the pneumatic drive *16*, and the turning cut-off gate *2* closes, leaving in the accurate fill chamber a small amount of material (Fig. 3*d*). If between batching cycles a small quantity of material pours from the transport chute because of external vibrations, this material flows not into the receiving hopper of the batcher *5* but rather into the accurate fill chamber *4* and does not degrade batching accuracy.

It is evident that just like in the construction of the vibrating feeder shown in Fig. 2 the presence of the accurate fill chamber, located in the sealing case, makes it possible to use a one-speed operating regime of the vibrator with two-

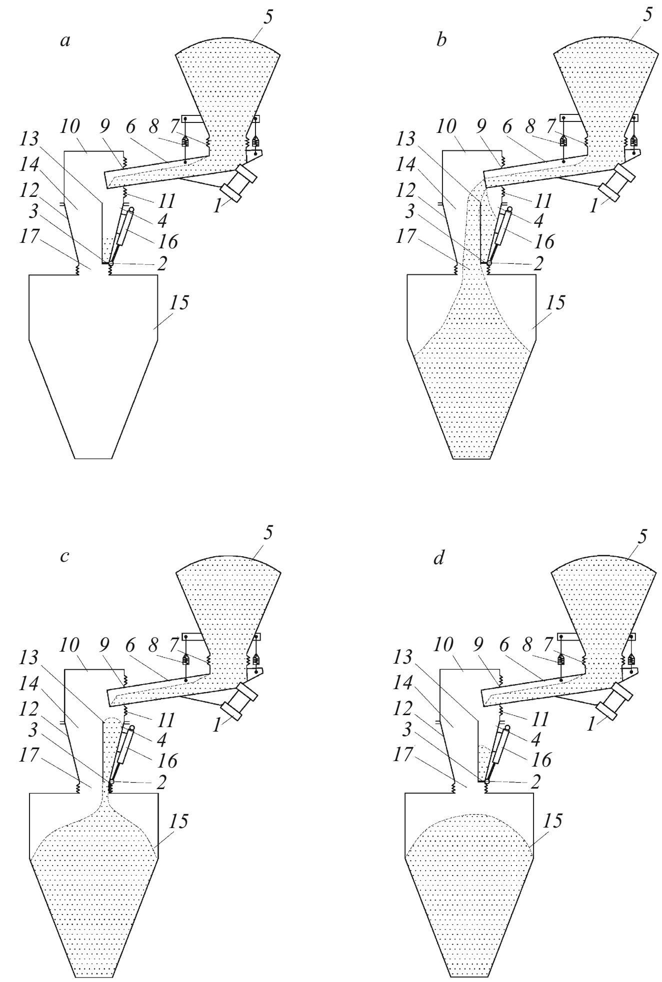

Fig. 3. Vibrating feeder with a feed hopper: *a*) initial state; *b*) "rough" loading regime; *c*) accurate loading regime; *d*) completion of the accurate loading regime.

speed feeding of material. In addition, the arrangement of the turning cut-off gate on the structure not subjected to vibrations increases the mechanical reliability of the pneumatic drive and stabilizes the accurate fill performed in the regime where material flows out under gravity.

The principle of vibration-gravity feed of material in both designs of vibrating feeders makes it possible to use the one-speed operating regime of unbalanced vibrators with two-speed feeding of material into the batcher and eliminates any effect of resonance phenomena when the vibrators are switched off, which increases the accuracy with which the bulk components of a glass mix are batched and makes the operation of vibrating feeders with an unbalance electric drive more efficient.

REFERENCES

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